

DEPARTMENT OF TRANSPORTATION
ENGINEERING SERVICE CENTER
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CRITERIA FOR SELECTION OF PERMEABLE MATERIALS

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read “**SAFETY AND HEALTH**” in Section C of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SPECIFICATIONS

1. REQUIREMENTS

- a. A satisfactory permeable material for underdrains, stabilization trenches, and pervious subgrade blankets should meet the following two requirements: (1) Its permeability must be several times that of the soil to be drained; and (2) it must be so graded that it will not become clogged by migration of the soil into the permeable bed.

2. CLASSES OF PERMEABLE MATERIAL

- a. The Standard Specifications include grading requirements for two different classes of Permeable Material described as “Class 1” and “Class 2”. The class should be selected by the engineer, according to the character of the soil being drained, as described in detail hereinafter. The choice of type of material within “Class 1” should be optional with the contractor.

3. MODIFICATION OF STANDARD SPECIFICATIONS

- a. Source: If permeable material is to be furnished by commercial producing plants, the Standard Specifications should be used without modification. If

it is uneconomical to obtain the permeable material from commercial sources, local sources should be investigated during the Materials Survey, and the District Materials Report should include recommendations for the permeable material.

- b. Permissible Modifications: Certain clean coarse natural river gravels and some beach sands are satisfactory for permeable backfill materials, even though the gradation may not be within the limits for any of the types shown in the Standard Specifications. Material from proposed local sources should be tested by, and the proposed modified grading requirements approved by the Transportation Laboratory if there is to be any change from the Standard Specifications.

B. DESIGN OF PERMEABLE MATERIAL

1. DESIGN CRITERIA

- a. Aquifers: The two criteria, permeability and resistance to soil migration, for gradation of a bed of permeable material are both influenced by the character of the aquifer, i.e., the soil to be drained. If the aquifer is a coarse sand, a bed of high permeability is required in order to satisfy the design criterion that the backfill material be several times as permeable as

the soil. The coarse sand would not readily migrate into the permeable material bed, and therefore, a relatively open graded material would be satisfactory.

- b. Clay Aquifers: A highly cohesive clay aquifer would resist filtration of soil into the permeable bed because of the cohesion of the clay. Although a completely homogeneous bed of clay would carry very little groundwater, large amounts of groundwater frequently flow through fissures, partings, joints, and other small openings in clay soils. If the clay soils do not contain significant beds or layers of cohesionless or slightly plastic fines, the use of graded permeable material might not be necessary.
- c. Critical Aquifers: The soils most susceptible to migration into the permeable material are the cohesionless, very fine sands or silts. Such aquifers require a graded permeable material to prevent clogging of the permeable material bed by migration of the soil.

2. CONTROL TESTS

- a. Critical Soil Properties: Control tests performed in the field will aid the engineer in the selection of the proper class of permeable material. It is recognized that several soil properties influence the functioning of subdrain systems, but in order to simplify testing and design procedure, the engineer should be guided in his/her selection of the class of permeable material by two soil properties: grain size distribution and plasticity. The former will be determined by Sieve Analysis, California Test 202, because the Plastic Limit and Liquid Limit tests are not appropriate for field use, plasticity of the soil will be measured indirectly by correlation with the Bar Lineal Shrinkage, California Test 228.

3. PRELIMINARY DESIGN

- a. Engineer's Role: The final determination of class of permeable material to be designated at each

individual installation will be made by the Resident Engineer. The District Materials Engineer should be available for consultation if aid in making the final determination is requested by the Resident Engineer. This determination should be based on engineering judgment as well as on the field sieve analysis and lineal shrinkage test results of soils exposed in each trench or other location where the permeable material is to be placed. When the District Materials Engineer makes the soil survey (for preparation of the Materials Report) he/she must estimate as accurately as possible which class of permeable material may be required at each installation on the project. This is essential in order that the preliminary estimate include the proper quantity of each class of permeable material as accurately as can be determined from soil data obtainable in the soil survey.

4. SOIL SAMPLES

- a. Selection of Soil Samples: It is important that the design of the permeable material be based on soil samples that are properly selected. Since the soil tests are primarily for determining the susceptibility of the soil to infiltration into the permeable material bed, the samples should be selected from the soil most critical with respect to migration into the bed. The soil will seldom be homogenous within the limits of one proposed installation on a project, and tests should be made on the most critical soils present in any significant quantity in any known or potential aquifer. The critical soils are generally the fine-grained cohesionless soils such as silts and very fine sand, which usually require Class 2 permeable material.
- b. Thickness of Critical Aquifers: Very thin layers or partings of critical soils may be disregarded; for example, a layer of silt or clay only a fraction of an inch in thickness, if all of the other soil would meet the criteria for Class 1 permeable material. If the critical soil, however, is present in layers or zones several inches

in thickness, this soil should control the selection of the class of permeable material even though it might represent a minor portion of the total soil that would be in contact with the permeable material.

- c. Importance of Critical Aquifer: Similarly, if any portion of a single installation on a project contains critical soil which would require Class 2 permeable material, the entire installation should be made with the Class 2 material, unless the area being drained is of such magnitude that it is practical to use two classes of permeable material.

5. TESTING

- a. Simple Plasticity Test: Sieve Analysis and Bar Lineal Shrinkage Tests should be made on representative samples of the soil which have been carefully selected as described above. If, however, the soil is non-plastic or only slightly plastic, it is unnecessary to perform the Bar Lineal Shrinkage Test as the lineal shrinkage will be 8 or less. The plasticity can be estimated by rolling a properly moistened portion of the soil fines in the hand. If the moistened soil cannot be rolled out into a 3.2-mm diameter thread, or can be so molded only with difficulty, the soil has very little plasticity and the lineal shrinkage can be assumed to be less than 8. If, however, the soil forms a tough thread when so manipulated, high plasticity is indicated and the Bar Lineal Shrinkage Test may show that the plasticity is such that Class 1 permeable material might be satisfactory.

6. SELECTION OF CLASS OF PERMEABLE MATERIAL

- a. Use of Table 1: After the grain size distribution and lineal shrinkage have been determined, select the class of permeable material by use of the attached Table 1, "Criteria for Selecting Class of Permeable Material". If several soil samples from one proposed installation indicate that different classes of permeable material will be required, the class to be used should usually be the

finest gradation required by any of the soils tested.

TABLE I
CRITERIA FOR SELECTING CLASS OF
PERMEABLE MATERIAL

For soil types having the following gradation and lineal shrinkage, either Class 1 or Class 2 may be used.

Soil Type	If 0 to 85% passes Sieve No.	and	Not more than 50% passes Sieve No.	and	Bar Lineal Shrinkage is
(1)	1.18 mm		300 mm		Any value
(2)	600 mm		150 mm		above 9
(3)	300 mm		75 mm		greater than 12

CLASS 2 PERMEABLE MATERIAL SHOULD GENERALLY BE USED FOR ALL SOILS HAVING PROPERTIES OTHER THAN LISTED ABOVE.

C. SAFETY AND HEALTH

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans' Laboratory Safety Manual.

Users of this method do so at their own risk.

REFERENCES:

California Standard Specifications
California Tests 202 and 228
End of Text (3 Pages) on California Test 120